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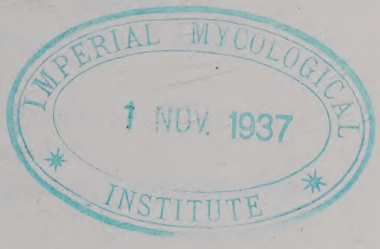
Pamphlet No. 16

DEPARTMENT OF AGRICULTURE
TANGANYIKA TERRITORY

The Sisal Experimental Station

Report for the year 1936



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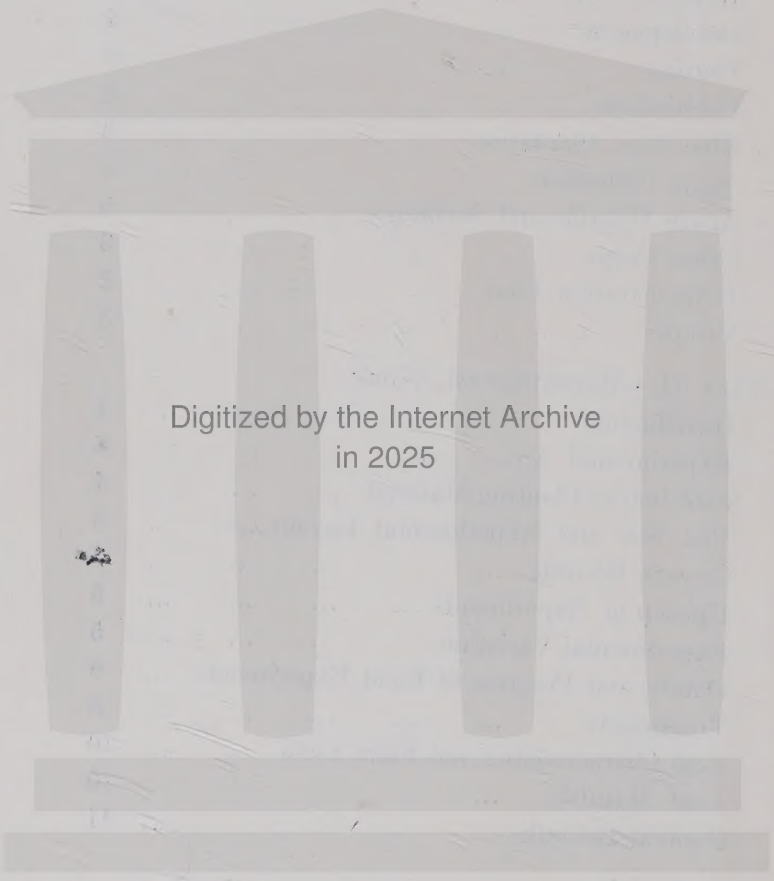

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Report on the Sisal Experimental Station

Foreword.

This is the second annual report to be presented since the inception of the station in late 1934 and it reviews an interesting stage in its history. The report is divided into two parts, the first dealing with development and general administration and the second comments upon the progress of experimental work. Within a space of eighteen months field trials had begun on Mlingano Estate.

PART I.

1. Staff: *European.*—Mr G. W. Lock, Agricultural Officer, remained in charge throughout the year assisted by Mr H. A. B. Fowler, Agricultural Assistant.

2. *African.*—The African staff was increased in order to help during planting and subsequently to cope with the recording and compilation of growth measurements. A small gang of selected intelligent labourers is employed regularly for the upkeep of the experimental areas. Ordinary field labour has not been forthcoming in adequate numbers for work in other parts of the estate.

3. Buildings and Equipment.—The office and laboratory were occupied early in January. No additional constructional work has been undertaken. The erection of the factory and a labour camp awaits the provision of a satisfactory water supply; final plans of the latter are now being drawn up and this work can be proceeded with in the near future. The station has been well equipped with a wide range of apparatus for laboratory and field work.

4. Water Supply.—The old dam at the far end of the estate, which was repaired and strengthened last year, filled rapidly to overflowing in May after the porous soil in the catchment area had reached saturation point. The level of the water also rose a little on two subsequent occasions following heavy downpours of rain. This dam is not well sited and has a shallow storage area. Clearing the valley a few hundred yards below it has revealed a better situation where it is intended to put a properly constructed dam which it is considered will collect sufficient water for the needs of the station.

After prolonged pumping by the Public Works Department, the borehole proved disappointing both as regards quantity and quality of water supplied. A trace two and a quarter miles long was cut to the Mkulumuzi river and the route for a pipeline surveyed. The capital cost of this project would be unduly heavy.

5. Weather.—In view of the important planting programme which had to be carried out in 1936, it was indeed fortunate that

the rains were above average and well distributed. This has resulted in the sisal in the experimental plots becoming uniformly established; if this had not been the case, the variation caused by irregular "striking" would probably have persisted for the duration of the experiments. At one period in April apprehension was caused by the onset of a short spell of dry weather; the spacing trial was the only one to suffer temporarily and eventually made a good recovery.

The rainfall for 1936 amounted to 1,335·4mm. (52·5in.) which fell on 147 days. Similar records for the previous year were respectively 1,252·2mm. and 109 days. Meteorological observations include maximum and minimum temperatures, humidity, sunshine records and evaporation. The British East African Meteorological Service has assisted materially by providing instruments.

6. Development of the Station.—Although an extensive amount of development work, chiefly of the nature of clearing and preparing trial grounds and the layout of the station, had been carried out during the first year, on a large estate such as this development work could not be brought to finality in so short a time. During the past year a large portion of the citrus valley was cleared, gardens prepared, vestiges of building operations removed and estate roads extended. In addition repeated weedings and cut-lassings of seedling rubber growth in the southern section of the estate were necessary.

Lawns have been established, ornamental trees and shrubs are growing, and the station itself is now situated in neat attractive surroundings. The felled rubber on the remaining sections is rapidly perishing through the agencies of white ants and borers so that in future clearing operations there will be less bulk of material to handle and much of it can be burnt. Another bulbil nursery has been planted.

7. Touring.—The majority of estates in the Tanga province were visited. Touring has been restricted by the need for remaining on the station to supervise planting and organize recording work. A tour was made of the principal sisal growing areas of Kenya during August and September.

8. Publications.—Beginning in July the usual quarterly reports were replaced by the issue of a series of quarterly notes giving an informal description of the activities of the station. In these notes it is endeavoured to keep sisal growers acquainted with the progress of the experiments and any other investigational findings. The third number has been submitted recently; the notes are printed by the Government Printer and are circulated by courtesy of the Tanganyika Sisal Growers' Association.

An article giving a comparative description of cultivation methods of sisal in Kenya and Tanganyika, based upon a report made on the visit to Kenya, has been accepted for publication in the *East African Agricultural Journal*. A popular account of sisal production in Tanganyika was written and submitted to the *Farmer and Stockbreeder*, London.

9. Blue Sisal Plantation.—The plantation of blue sisal (*Agave amaniensis*) was extended and now covers nine hectares (22¼ acres). The growth this species makes continues to astonish sisal growers. Lower leaves now average about three feet in length and it is becoming clear that the time to start cutting blue sisal will be earlier than that normally regarded suitable for common sisal. 58,950 suckers were issued to estates in the Tanga province which represents an average stolon production of 3·35 per plant in a period of twenty-one months.

10. Agave Collection.—Plantings of certain species were repeated this year with the object of providing an annual succession of poling agaves for breeding work. Other agaves added to the collection are *A. sisalana* (La Mortola Capt. T.1 and T.2), *A. nirvana*, *A. miradorensis*, *A. fourcroydes*, *rigida*, and *A. fortunæ*, all received from Amani. A small plot of *A. zapupe* is included also. Bulbils taken from a parent plant of *A. sisalana* which had produced an exceptionally large number of leaves on a tall trunk were planted in the nursery. It will be interesting to see if the progeny retain these characteristics of the parent.

11. Agave Hybrids and Seedlings.—Over three thousand agave hybrids and seedlings raised at Amani by the Geneticist are growing on the station. The hybrids represented are *A. amaniensis* × *A. angustifolia* and vice versa, seedlings of *A. amaniensis* (selfed) and *A. fortunæ* (open-pollinated) and a few plants of seedling No. A40. There is a diversity of types and it is too early to discuss their possibilities.

12. Other Crops : (a) *Ramie.*—Three acres of *Bœhmeria nivea* have been planted and a smaller area as well with *B. utilis*. Despite a wet year, both have made patchy growth, partially due to two types of root cuttings being used. Two cuttings have been taken from the *B. nivea* plot.

(b) *Mundulea suberosa.*—Seedlings of this shrub, the bark of which has possibilities as an insecticide (under investigation at Amani) have grown strongly and the bushes are now five feet high.

(c) *Derris elliptica.*—A few plants of *D. elliptica* received from Amani are growing satisfactorily although planted at an unfavourable time.

(d) *Citrus.*—Nearly one thousand stocks were successfully budded nine months ago with budwood of several citrus varieties taken from trees on the Muheza citrus plot. They are making good progress and many will be ready for planting out next rains. It is intended to extend this feature of the station as soon as the season permits in order that budded trees will be available for issue to sisal growers.

(e) *Maize.*—Two acres of maize were sown in the citrus valley and the crop used for feeding labour.

13. Demonstration Plots.—Twenty demonstration plots, each a quarter hectare in area have been planted east of the Kibaranga road. Various cultural methods for sisal will be demonstrated.

14. Visitors.—Visitors to the station included His Excellency the Governor accompanied by the Provincial Commissioner, Tanga;

the Director of Agriculture; the Acting Director of Agriculture; the Directors of Agriculture, Kenya and Uganda; the Director, East African Agricultural Research Station, Amani; the Treasurer; the Chief Scientific Officer, Lyamungo; the Deputy Director of Agriculture, Uganda; Major the honourable Sir William Lead; Major A. King; J. V. Gray, Esq.; H. Tanner, Esq.; G. Gaedhe, Esq.; P. Eltester, Esq.; German Vice-Consul, Nairobi; O. Werner, Esq.; Colonel the honourable M. T. Boscawen; E. W. Bovill, Esq., London; A. Karimjee, Esq.; the Secretary, Tanganyika Sisal Growers' Association; officers attending the East African Agricultural Conference, Amani; members of the Amani staff and a large number of sisal growers in Tanganyika in addition to several visitors from Kenya and Uganda.

15. The closest relationship is maintained with the East African Agricultural Research Station, Amani, and assistance rendered in many ways is gratefully acknowledged. In particular, investigations made by Mr L. R. Doughty, Geneticist, on the sisal plant and experimentation with this crop during past years provided especially valuable guidance for laying down trials at Mlingano.

Reports on sisal investigational work have been exchanged with Dr Gibson, Director of Sisal Research, Linen Research Association, Lambeg, Northern Ireland, and with the Department of Agriculture, Kenya.

PART II.—EXPERIMENTAL WORK.

Introduction.—A high level of uniformity is desirable when starting field experiments. Not only is uniformity of soil and its preparation wanted but another requirement is uniformity among the plants to be subjected to experimentation. Absolutely uniform soil is unobtainable, but with a wise choice of site and replication of plots in a well-designed layout, variation brought about by soil differences can be reduced and afterwards largely eliminated from the experimental results by statistical methods. With many crops, especially fruiting crops reproduced by seed, inherent variability of the plants themselves constitutes one of the major problems which have to be studied before field trials can begin. This form of variation can be extremely wide, entirely masking treatment effects. Happily there are no difficulties of this nature in the case of sisal. Investigations at Amani by the Geneticist, prior to the institution of this station, showed that sisal is a clone; it is also easily propagated by vegetative means. These are valuable attributes implying that field experimental work could be embarked upon as soon as season and nursery plants permitted.

2. Experimental Areas.—A primary advantage possessed by Mlingano Estate is that it contains areas of good level land with a uniform red soil suited for sisal experiments.

3. Selection of Planting Material.—As outlined in Pamphlet No. 14 it was proposed to use bulbil planting material in preference to suckers for the experiments. Latterly the progress of

certain trials where both kinds have been planted has justified this decision. In the young stages the bulbil plants are markedly more even and symmetrical, besides having grown faster than the sucker plants; many of the sucker plants are mis-shapen and a higher proportion failed to "strike."

Last year bulbils were collected from well-developed poles and graded for size before planting in the nursery. After spending a year in the nursery, they were selected for general vigour and development and graded again when transplanted to the experimental areas. Plants fifteen inches high were mainly used. As mentioned earlier in this report, weather favoured planting.

4. Plot Size and Experimental Layout.—In the majority of experiments a plot size of ·0075 hectare (·0185 acre) has been adopted. Each plot comprises twenty-five plants arranged in five rows spaced 3m. × 1m. (9′9″ × 3′3″) and the plants are adequately protected from the influence of adjacent plots by guard rows; an entire plot consists of sixty-three plants or seven rows of nine plants each. An analysis of variance for plots of different numbers made by the Geneticist, using numbers and weights of leaf cut from an area of sisal at Amani treated uniformly showed that with twenty-four plants in a rectangular plot, replicated six times, differences of a fairly low order would be significant using either set of data. Therefore it is felt that the size of plot chosen will be satisfactory under the more uniform conditions prevailing at Mlingano. Where plots have been subdivided the plant number has been increased to thirty or forty-eight. Spacing is wider than in normal practice in order to provide access to the plants once they are fully grown.

Of the thirteen field trials laid down this year, the latin square layout has been used for eight and randomized blocks for the other five trials. With randomized blocks it is possible to avoid anthills and make fuller use of the experimental area. Plots are numbered in series irrespective of treatment and demarcated by white posts.

5. Growth Records.—Sisal growth is gauged by counting the number of new leaves produced and also by measuring the height of the bud or central spike. New leaves are marked by snipping off part of the terminal thorn; this has no ill-effects. Records are taken monthly in four trials of principal importance, and bi-monthly in the others in order to reduce compilation work in the office. Over fifteen thousand plants have now been recorded since July or during a period lasting six months. Adding and calculating machines facilitate accurate and rapid analysis of records.

6. Upkeep of Experiments.—All trials are continually kept free from weeds except, obviously, certain plots in the cultivation trial. The growth of the sisal has been very satisfactory since it was planted in April or May.

7. Experimental Variation.—In view of the opening paragraph dealing with the establishment of experiments, some indication of the standard of uniformity gained since putting down these trials can be gathered from an analysis of growth records taken from the common sisal cutting trial. As the plants in the trial are still too

immature for cutting, the growth in all plots remains unbiased by different treatments purposely applied. After allowing for variation due to position, i.e. soil variation, the coefficient of variability calculated on the total number of new leaves produced during five months was 3·74 per cent and that for height of bud at the end of this period was only 1·63 per cent. The latter figure, to give another instance, in the interplanting trial (where treatments have been applied) was 1·91 per cent after eight months. For the benefit of the layman, the coefficient of variability is a convenient measure of variation; it is the standard deviation expressed as a percentage of the mean; the higher the percentage the more diverse the material. The coefficient of variability for mature estate sisal, judging by the number of leaves per plant, appears to hover between 20 to 30 per cent. This makes estate sisal generally unsuitable for experimental work.

It may be claimed that these results reflect the care taken when the experiments were planted, aided by favourable weather conditions. The records to date, however, only concern two simple vegetative characteristics. When the time comes to determine results of fibre yields, it is not supposed that differences between treatments will be detected quite so precisely. Fibre production is influenced by more factors than are the two indices used for representing plant growth.

8. Details and Progress of Field Experiments.—Brief particulars of each experiment are given below together with notes on progress. Undue significance should not be attached to figures which solely represent growth rates during the first six months and cannot be accepted as indicative of fibre yields. A difference between any two treatments is not regarded as attributable to treatment effects unless it exceeds the figure calculated for a "significant difference."

(a) cultivation trial.

Layout: 6 × 6 Latin square.

Analysis of Growth Records to 4th December 1936.

Treatment	Mean No. of new leaves produced per plant	Mean height of bud (cms.)
Clean weeding	20·8 ...	52·3
Clean weeding and deep cultivation	18·6 ...	50·3
Cover crop	17·2 ...	48·4
Weeding every three months ...	16·2 ...	48·6
Cutlassing weeds	13·9 ...	48.1
No weed control	12·2 ...	47·7
General mean	16·48 ...	49·23
Standard error	0·43 ...	0·92
Significant difference	1·37 ...	2·90

Significant differences arise between all the treatments except between the cover crop (*Calopogonium mucunoides*) and weeding periodically. As regards height of bud no significant differences

occur except between clean weeding and the last four treatments tabulated.

More suckers were produced under conditions of clean weeding than under the other treatments; although sucker production was most prolific in plots clean weeded without deep cultivation, this was not significantly higher than in the case of clean weeding combined with deep cultivation.

The experiment illustrates how sisal responds to clean weeding in its first year after transplanting. Plants open to air and sunshine have a better colour, a deep bluish-green, than those competing with weeds. Any beneficial effects from the cover crop are not yet observable.

(b) BULBILS *v.* SUCKERS TRIAL.

Layout: 6 × 6 Latin square with two subplots of fifteen plants each per plot.

Analysis of Growth Records to 25th December 1936.

Treatment	Mean No. of new leaves per plant
Bulbils planted shallowly	15·8
Bulbils planted deeply	15·4
Small bulbil plants	13·4
Suckers planted shallowly	11·8
Small sucker plants	11·6
Suckers planted deeply	11·3
General mean	13·22
Standard error	0·39
Significant difference	1·25

Bulbils show significantly more rapid growth than suckers. Otherwise there are no significant differences apart from small bulbil plants comparing unfavourably with larger ones. Each plot was divided into two subplots; in one half the sisal was planted exactly as lifted from the nursery or field; in the other half roots were trimmed and some of the leaves cut off. The latter treatment significantly depressed the growth rate.

(c) VARIETY TRIAL.

Layout: Six randomized blocks of six plots each.

Analysis of Growth Records to 8th December 1936.

Treatment	Mean No. of new leaves produced per plant	Mean height of bud (cms.)
A. sisalana bulbils	20·4 ...	58·5
A. sisalana suckers	15·5 ...	55·0
A. amaniensis bulbils	17·7 ...	73·2
A. amaniensis suckers	18·0 ...	70·2
A. fourcroydes bulbils	14·8 ...	45·8
A. cantala suckers	14·3 ...	52·8
General mean	16·79 ...	59·27
Standard error	0·56 ...	1·25
Significant difference	1·25 ...	3·93

Here also common sisal bulbils have produced more new leaves than suckers of the same species but there is so far no significant difference in height of bud. There are no significant differences between bulbils and suckers of blue sisal (*A. amaniensis*). Common sisal bulbil plants have developed more leaves than blue sisal but the bud height (indicating the length of the last leaves to open) of blue sisal has become significantly taller. The other varieties, *A. cantala* and *A. foureroydes*, lag behind in development but the comparison is unfair because originally plants equal in size to the common and blue sisal were not available. These species were included in the trial mainly for academic interest.

(d) INTERPLANTING TRIAL.

Layout: Eight randomized blocks of four plots each.

Analysis of Growth Records to 9th November 1936.

Treatment	Mean No. of new leaves produced per plant	Mean height of bud (cms.)
No cropping; clean weeding ...	17·4	51·6
Beans interplanted	17·7	51·5
Maize interplanted	16·7	52·6
Cotton interplanted	16·3	52·4
General mean	17·05	52·05
Standard error	0·17	0·50
Significant difference	0·58	1·22

Interplanting with maize or cotton has depressed leaf growth slightly compared with clean weeding. No significant differences exist with reference to height of bud. Despite maize and cotton having a mildly adverse effect upon the sisal this can hardly be regarded as worse than might be anticipated from periodical weed competition.

(e) SPACING TRIAL.

Layout: Six randomized blocks of eight plots each.

The spacings used represent various densities of plants per unit area of land ranging from 1,600 to 10,000 per hectare (674 to 4,004 per acre). The internal measurements of each plot are 12m. × 10m. (·012 hectare or ·029 acre). Two spacings had to be adjusted to fit the plot size and consequently are not orthodox but they are the nearest approach to those used in practice. Growth has not advanced sufficiently to make plant competition evident.

(f) COMMON SISAL CUTTING TRIAL.

Layout: 7 × 7 Latin square.

Eventually this trial will compare seven systems of cutting sisal varying from hard and frequent to light and infrequent cutting.

(g) COMMON SISAL *v.* BLUE SISAL CUTTING TRIAL.

Layout: Six randomized blocks of six plots each divided into three subplots of sixteen plants each.

TREATMENTS.—A third of the plots of both common sisal and blue sisal will be cut at respectively the second, third and fourth

year from planting in the field. Once cutting has begun a part of each plot will be cut at intervals of six, twelve and eighteen months. Except between the two varieties, no differences can be determined at present.

(h) SUCKER CONTROL TRIAL.

Layout: Six randomized blocks of four plots each.

Treatments have not become operative owing to insufficient sucker growth.

(j) MANURIAL TRIALS.

There are four of these trials, each a 6 × 6 Latin square with 25 plants per plot. Treatments embody all combinations of nitrogen, phosphate, potash and lime. Fertilisers were applied in September using the following rates of application :—

	Per hectare		Per acre
Sulphate of ammonia ...	cwts. 5 ...	cwts.	2
Sulphate of potash ...	,, 5 ...	,,	2
Double superphosphate ...	,, 6 ...	,,	24
Lime	,, 50 ...	,,	20

Treatments have had no effect to date.

(k) BLUE SISAL SPACING TRIAL.

Layout: 4 × 4 Latin square; area of each plot ·012 hectare (·029 acre).

Blue sisal has been planted at four different spacings. Plant competition has not begun.

(l) NURSERY SPACING AND MANURIAL TRIALS.

These small experiments in the nursery last year did not give any results; even at close spacing for at least seven months the plantlets have sufficient room to grow without hindrance. Neither have they developed a root system extensive enough to take full advantage of fertilisers. Variation in development in the nursery was mainly sporadic and not confined to particular patches of soil but growth is sometimes retarded in the early stages should the base of the bulbil become partially buried.

9. SISAL DISEASES AND ESTATE TRIALS.—Stump rot has been more prevalent this year in estate sisal especially where the soil is poor or subject to water-logging. There are two forms of stump rot and both have been examined by the Plant Pathologist who thinks they are physiological diseases. In one form the leaves become yellow, curl lengthwise but remain rigid as if the plant was poling; in the other an early symptom is that the leaves droop, are twisted but retain a green colour for some time before yellowing. The latter type of stump rot was principally confined to sisal growing on anthills. Manurial trials have been started in the hope of elucidating whether the disease is attributable to any mineral deficiency in the soil. Results from the banding disease trial have not yet been determined. Another manurial trial, and a spacing trial situated in a dry locality, are still in progress.

10. Leaf Characteristics and Fibre Yield.—A few groups of estates in the Tanga province kindly supplied data of a large number of decortication tests taken in their factories, frequently as a matter of routine. Analysis of the figures give a high positive correlation between leaf weight and the weight of fibre contained in the leaf; a similar correlation occurs between leaf length and leaf weight, thus confirming results obtained at Amani from a smaller number of examples. Hence heavy leaf implies long leaf and more weight of fibre and the relationship does not change for different degrees of fibre percentage. It is still necessary to ascertain the fibre percentage before yields can be estimated upon leaf characteristics.

11. Leaf Maturity.—An endeavour has been made to determine within limits the angle dividing "mature" from "immature" leaves on a sisal plant which, if known, might give one standard by which cutting should be controlled. This angle is commonly supposed to be about 45° from the horizontal. Single leaves taken at various angles on the plant from ground level upwards, including one from inside the bud, were hand decorticated, the fibre counted, graded and weighed. Four plants of different ages were examined and from the results obtained by these methods, no notable differences could be detected between lower and upper leaves except that there was less weight of fibre in the unfurled leaf. Unfortunately it is not easy to extract fibre from single leaves accurately.

The question was then tackled in another way with the co-operation of a local planter who kindly provided the necessary facilities. Eighty plants of sisal almost ready for the first cutting, were cut to the bud and the leaf between four angles from the horizontal, i.e. ground-level to $22\frac{1}{2}°$, $22\frac{1}{2}°$–$45°$, $45°$–$67\frac{1}{2}°$, $67\frac{1}{2}°$ to bud, was kept separate. Sufficient bulk of leaf occurred in each group to allow decortication on a full-sized decorticator. The results are tabulated below :—

	Angle Groups			
	0-22½°	22½°-45°	45°-67½°	67½°-bud
Number of leaves cut ...	29	12	7	13
Total weight of leaf (kgs.)	14·3	8·8	5·1	9·7
Total weight of extracted fibre (gms.)	334	216	133	298
Per cent extracted fibre by weight	2·34	2·46	2·59	3·06
Average weight of a single leaf (gms.)	468	681	738	712
Average length of leaf (cms.)	92	114	118	119
Average weight extracted fibre per leaf (cms.) ...	11·4	18·0	19·4	22·2

According to these figures, which give a rough idea of the status of the leaves on a sisal plant when ready for a first cutting, it is not possible to distinguish mature from immature leaf. The leaf tends to improve in many respects at the higher angles; this suggests the manner in which the plant as a whole is maturing. It is intended to continue the investigation, using older plants.

12. General Remarks.—A beginning has now been made with field experimental work on sisal. As the plant is a perennial a few years must elapse before it will be possible to supply any conclusive results. Most of the experiments are designed to answer simple questions but once a better conception of the behaviour of sisal under various cultural conditions has been arrived at, it is intended to enlarge the scope of future experiments by incorporating the salient findings of two or more of the trials started this year. Throughout this work it is not overlooked that the intrinsic purpose of this station is to resolve how the producers may gain the most profitable results in the field.

Sisal Experimental Station,
Ngomeni, Tanga,
15th January 1936.

G. W. Lock,
Agricultural Officer (Sisal)

Appendix 1

Rainfall Records 1936.

Month	Amount of Rain (mm.)	No. of Days Rain.
January	46·2 ...	7
February	121·8 ...	11
March	13·1 ...	3
April	189·7 ...	19
May	268·1 ...	22
June	190·2 ...	16
July	31·6 ...	12
August	153·9 ...	10
September	94·8 ...	16
October	152·3 ...	10
November	27·9 ...	8
December	45·8 ...	13
Total ...	1,335·4 ...	147